

## **PS/SS: Modeling**

Estimated Cost:      \$100,000 (requested RMP 2013 funds)  
                             \$100,000 (existing RMP 2012 modeling funds)  
                             \$300,000 (proposed non-RMP Nutrient Strategy funds in  
                             2013)  
Oversight Group:    Contaminant Fate Work Group and Nutrient Science Advisory  
                             Group  
Proposed by:        Don Yee and David Senn, SFEI

## **Background**

In joint meetings with members of the Nutrient and Modeling teams on May 1st and June 4th, 2012, modeling needs for different stakeholder efforts (e.g., RMP contaminant fate, RMP nutrient work, Bay Nutrient Strategy), were explored, and some commonalities supporting the use of a shared modeling platform were identified. Although key institutional agreements for the development and maintenance of such shared modeling tools have not yet been reached, a potential path forward is outlined here.

In the May meeting, a recommendation was made to explore adaptation of open source models already used and validated in projects by other agencies in order to minimize the effort and cost of development and to have a partner agency with interest in long-term support of the model platform for the Bay. Delft3D, used by the USGS in modeling sand fate within the Bay and outside the Golden Gate, and used in other areas worldwide for integrated modeling of hydrodynamics, sediment, and water quality contaminants, was identified as a potential tool.

## **Study Objective and Applicable RMP Management Question**

The objective of this effort is to develop models that can be applied to answer questions regarding nutrient and contaminant cycling in the Bay. This study would address the following RMP management questions (MQs):

### *Nutrients*

1. Which nutrient sources, pathways, and transformation processes contribute most to concern?
  - a. What is the relative contribution of each loading pathway (WWTP, Delta, non-point source, etc.) to the Bay overall and the Bay's key sub-systems, and how do these loads vary seasonally?
  - b. What is contribution of nutrient regeneration (benthic fluxes) from sediments and denitrification/nitrogen fixation to SF Bay nutrient budgets?
2. What nutrient loads can the Bay assimilate (without impairment of beneficial uses)?

3. What future impairment is predicted for nutrients in the Bay?

*Modeling/Forecasting*

- 1) What patterns of biota exposure to contaminants of concern are forecast for major segments of the Bay under various management scenarios?
- 2) What is the contribution of contaminated Bay margins to Bay impairment?
- 3) What are the projected impacts of Bay margin management actions to Bay recovery?

## **Approach**

Based on discussions with stakeholders, the tasks described here were identified as a logical and deliberate approach to developing a sustainable modeling program across a range of contaminants. This approach relies on coordination among multiple initiatives in order to leverage funds. These initiatives include RMP contaminant fate, RMP nutrients, and the Bay Nutrient Strategy. The first several months of the proposed work involves detailed planning to clarify the science needs of important management decisions that will be addressed through modeling, and development of a modeling approach that appropriately targets those needs. This planning period will also allow us to further solidify the coordination between initiatives, and to begin establishing the necessary institutional agreements. In late 2012 or early 2013 model development will commence.

Tasks 1 through 3 will be conducted in 2012 using funds from the previously allocated \$100,000 (2012 funding). Tasks 4 through 6 will begin in 2013, funded partly by RMP funds. Tasks 7 through 8 are longer term objectives.

**Task 1:** A technical report will be developed that explores the pros and cons of adopting Delft3D<sup>1</sup> as a model platform. The report will address a range of issues, including:

- a. Thoroughly develop management questions/issues that need to be addressed for contaminants and nutrients and identify the model requirements posed by those management issues. In particular, the question of what output will be needed from a model to address the management questions will be addressed.
- b. Evaluate technical abilities and limitations of Delft3D hydrodynamics, sediment and water quality packages for addressing the management issues.
- c. Estimate cost and time for initially developing the model (calibration, validation); running and maintaining the model; and interpreting scenarios/simulations.

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<sup>1</sup> Delft3D is used here as a placeholder; contingent on agreements with a partner agency to develop and maintain as a common platform.

- d. Identify institutional agreements that need to be established for longer-term support of Delft3D as a shared model platform. For example, what is needed to maximize collaboration with USGS and the model developer (Deltares)?
- e. Develop a draft work plan for nutrient and contaminant fate modeling.

Dates: July-October 2012 (includes 1-2 meetings with Modeling Team, and one set of revisions)

Cost: \$35K plus \$10K non RMP funds (includes Dr. Craig Jones' effort and SFEI staff time, and potentially engaging one or two key consultants).

**Task 2:** Establish a modeling technical team to work with stakeholders to evaluate the work plan laid out in Task 1. This group will provide input on the modeling approach, necessary resolution, parameterization, and calibration/validation for hydrodynamic, sediment, and water quality and contaminant modeling efforts. This team would be utilized across Tasks 2-7.

Date: October 2012

Cost: \$10K

**Task 3:** Revise white paper and finalize work plan based on workshop input in Task 2. Identify collaborators or consultants, or develop an RFP

Date: December 2012

Cost: \$15K

We propose that the remaining portion of the 2012 funds (\$40,000) be combined with proposed 2013 RMP funds (\$100,000), and with matching funds from other efforts (described below), to begin model development in Task 4 in 2012-2013. The ultimate direction taken in Tasks 4-8 will depend on the final approach developed in Tasks 1-3. Thus, the approach below is only broadly described as a proposed path. We propose to update the TRC and SC in Q4 of 2012, and solicit feedback on the suitability of the selected path relative to RMP goals.

**Task 4:** Develop underlying hydrodynamic & sediment transport model. If explorations in Tasks 1-3 indeed show that Delft3D meets our needs, the existing USGS Delft3D model (grid, boundary conditions) for sand transport might be used as a launch point. A team of collaborators/consultants will be selected to work with stakeholders and SFEI to develop hydrodynamic & sediment transport models. These underlying hydrodynamic and sediment transport models will be the foundation upon which contaminant fate and nutrient/water quality models are developed. An important component of this will include working with water quality and contaminant collaborators on issues related to grid aggregation to adjust the model resolution to levels that are appropriate for the relevant management questions.

Dates: January-June 2013

Approximate Cost: \$130K = \$100K (2012/2013 RMP modeling) + \$30K (non-RMP Nutrient funds)

**Task 5:** Develop low-resolution or pseudo-3D nutrient-phytoplankton water quality models for Suisun Bay and South Bay as a test bed for model parameterization. The development of “basic” biogeochemical models has been identified as a high priority project by the nutrient conceptual model technical team to quantitatively synthesize our understanding of the system, test/generate hypotheses, and inform data collection and future modeling and monitoring efforts. Integrated water quality models are often run at lower resolutions than hydrodynamics to allow for sufficiently fast run times to accommodate the calibration of numerous parameters and to allow for analyzing multiple scenarios. Nonetheless they require accurate underlying hydrodynamic inputs. Therefore, grid (and temporal) aggregation will be a critical aspect, requiring coordination between Tasks 4 and 5. Task 5 will use hydrodynamic flows from coarsely aggregated outputs of Task 4. One potential approach is for the nutrient/phytoplankton water quality model to be developed by a consultant in close collaboration with SFEI and the modeling technical team

Dates: Model development - January-June 2013

Approximate Cost: \$150K = \$130K (non-RMP Nutrient funds) + \$20K (RMP modeling)

**Task 6:** Once the model structure is developed, it will be handed off to SFEI staff who will run simulations and further refine the model, working with the modeling technical team and the water quality modeling consultant. Work will include: quantitatively synthesizing nutrient load and ambient concentration data (i.e., mass budgets); assessing the relative importance of processes regulating phytoplankton productivity (light limitation, benthic grazing, potential inhibition by  $\text{NH}_4$ , flushing) and nutrient cycling, and performing sensitivity analyses. Parameters with greatest impact will be refined so that model uncertainty is better understood before embarking on more spatially or temporally resolved efforts (Tasks 7 and 8). The experience gained in model development and calibration (e.g., in grid aggregation) can be used to address model uncertainty and applied to later implementation of the model for other contaminants.

Dates: Model application and refinement: June 2013-December 2014

Approximate cost 2013: \$150K = \$130K (non RMP Nutrient funds) + \$20K (RMP modeling)

Approximate cost 2014: \$250K (non-RMP Nutrient funds)

**Task 7:** Develop relatively low-resolution 3D water quality models for particle-reactive and bioaccumulative contaminants. An approach analogous to that taken in Tasks 6 will be followed, but a larger share of the focus will be on accurately modeling long-term sediment fate. Because of the long simulation times (decades) necessary to explore the effects of various management actions on contaminant concentrations in sediments and biota, model sensitivity to grid (and temporal) aggregation will also be investigated here so that uncertainty can be characterized.

Dates: January 2014-May 2015

Approximate Cost: TBD (~\$50K assemble data, ~\$25K optimize model for sediment fate, \$200K sensitivity testing & scenario runs)

**Task 8:** Develop 2<sup>nd</sup> generation nutrient/phytoplankton and contaminant models, and run simulations to evaluate the effectiveness of various management strategies, building on the experience gained in Task 4-7.

Dates: 2014-2016

Cost: TBD